

MIXED FLEET STUDY

SEPTEMBER 1, 1981

MIXED FLEET STUDY OBJECTIVE

THIS STUDY, CONDUCTED AT THE REQUEST OF THE AIR FORCE SPACE DIVISION, IS INTENDED TO DEFINE A VIABLE SCENARIO FOR A MIXED FLEET OF AN EXPENDABLE LAUNCH VEHICLE AND THE SPACE TRANSPORTATION SYSTEM DURING THE TRANSITION TO A FULLY OPERATIONAL SPACE TRANSPORTATION SYSTEM.

STUDY GROUND RULES

- MIXED FLEET SHOULD BE COMPLIMENTARY, NOT COMPETITIVE
- DOD MISSION MODEL WAS PRIME AREA FOR STUDY
- CONSIDERED TECHNICAL, PROGRAMMATIC AND COST ISSUES

MIXED FLEET CONSIDERATIONS

- MIXED FLEET COMPOSITION
 - ELV CONSOLIDATION
- DOD PAYLOAD USER REQUIREMENTS
 - LAUNCH VEHICLE PREFERENCE
 - LAUNCH ON DEMAND
 - MAN IN ORBIT REQUIREMENTS
 - SECURITY
- MISSION MODEL COMPATIBILITY
 - PERFORMANCE
 - TURN AROUND TIME
 - ALTERNATE/BACK UP REQUIREMENTS
- NATIONAL
 - USE OF MANNED ORBITER IN TIMES OF TENSION
 - SINGLE PAD VULNERABILITY
 - STS GROUNDING
 - FOREIGN COMPETITION/BALANCE OF PAYMENTS

MIXED FLEET HAS SUBSTANTIAL BENEFITS

- ASSURES DOD ACCESS TO SPACE ON DEMAND
- COMPLEMENTS STS CAPABILITY
 - TOTAL MISSION MODEL ACCOMMODATION
- COUNTERACTS FOREIGN COMPETITION/BALANCE OF PAYMENTS
- LESS VULNERABILITY TO FOREIGN INTERFERENCE

ELV CANDIDATE PAYLOAD CONSIDERATIONS

- CARGO OR DEDICATED STS FLIGHTS
 - MAN IN ORBIT SUPPORT
 - BOOSTER COMPATIBILITY
 - LAUNCH ON DEMAND REQUIREMENTS
 - SECURITY CONTROL AT ~~LAUNCH FACILITIES~~
 - INTEGRATION
 - LAUNCH FACILITY

ELV CONSOLIDATION

- CONSOLIDATE TO PROVIDE LOWER COST
 - FEWER CONTRACTORS & INTERFACES
 - HIGHER VOLUME FOR REMAINING ELV
 - REDUCED FACILITY & MAINTENANCE REQUIREMENTS

- CONSOLIDATION CRITERIA
 - FLEXIBILITY
 - ACCOMMODATE MULTIPLE MISSIONS
 - ADEQUATE PERFORMANCE FOR MISSION CAPTURE
 - GROWTH POTENTIAL
 - COST
 - PROGRAM
 - PER POUNDS TO ORBIT

TITAN IS THE ELV ANSWER

- CONSOLIDATION
 - ONLY GENERIC SYSTEM THAT CAN SATISFY MOST REQUIREMENTS
- PERFORMANCE
 - MOST PERFORMANCE CAPABILITY OF ALL AVAILABLE ELV'S
 - EXISTING CREWS AND FACILITIES AT ESMC & WSMC
 - RELATIVE EASY PERFORMANCE GROWTH PATH
- RELIABILITY
 - OPERATIONAL SYSTEM WITH DEMONSTRATED RELIABILITY
- FLEXIBILITY
 - BUILDING BLOCK VEHICLE
 - SINGLE OR MULTIPLE PAYLOADS (CARGO INTEGRATION)
 - 34D CORE ONLY VEHICLE CAPABILITY
 - MULTIPLE UPPER STAGE COMPATIBILITY

TITAN IS THE ELV ANSWER (CON'T)

COST

- LOWEST COST/LB TO GSO OF ALL ELV'S
- SIGNIFICANT UNIT COST REDUCTION AVAILABLE
 - CONSOLIDATION
 - MULTI-YEAR PROCUREMENT
 - LINE ITEM FUNDING FOR SUPPORT AND LAUNCH ACTIVITY
 - ADDITION OF NON DOD USERS

50-Hammiday

RECOMMENDED MISSION MODEL CAPTURE

LOCATION	MISSION	34D	SHROUD	UPPER STAGES
ESMC	DSCS III/III	7 SEG	10'	IUS OR T/S
	SM II	7 SEG	10'	IUS OR T/S
	PLANETARY			
	GALILEO	7 SEG	14'	CENTAUR
	HALLEY'S	5 1/2 SEG	10'	IUS OR T/S
	SOLAR POLAR			
WSMC	(ESA)	7 SEG	14'	CENTAUR + AKM
	VOIR	7 SEG	14'	CENTAUR
	INTELSAT	5 1/2 SEG	14'	IUS OR T/S
	SM I	5 1/2 SEG	10'	NO UPPER STAGE
	DMSP	CORE ONLY	10'	NO UPPER STAGE

MISSION MODEL ~~CUSTOM~~ BENEFITS

- MISSION MODEL COMPATIBILITY WITH STS
- ELV PLANETARY CAPABILITY
- DIRECT PATH TO OTV BY NASA
- EASY SOLUTION TO MISSION IV
- COMPETITION TO FOREIGN LAUNCH SYSTEMS

ELV ~~SATRE~~ - FLIGHT COUNT

LOCATION		84	85	86	87	88	89	90	91	92	93	TOTAL
ESMC -	DOD	1	3	1		1	3	1	2		3	14
	TITAN ELV OTHER		2	1	2	3	2	1		1	2	14
STS												
	DOD	2	2	4	7	7	8	10	10	8	8	64
	OTHER	5	6	11	14	21	23	27	26	30	27	190
	REFLIGHTS	1	1	1	2	2	2	2	2	2	2	19
WSMC -												
	TITAN ELV DOD	3	3	1	4	1	1	3	1	2	3	22
STS												
	DOD			2	3	4	7	6	8	5	5	40
	OTHER			2	0	3	3	5	5	7	6	31
	REFLIGHTS					1	1	1	1	1	1	6

* BASED ON NASA FLIGHT PROJECTION IN POP 81-2 AND DOD MISSION MODEL 10
NEW BUY 40 VEHICLES (INCLUDING 7 CORE VEHICLES)

TITAN CAPABILITY

	PARK ORBIT (80x95, i=28.5)	GSO	12 HOUR (CIR., i=28.5)
• ESMC*			
- TITAN 34D/NUS	35200	--	--
- TITAN 34D/TS	--	4100	7300
- TITAN 34D/IUS	--	4100	6350
• WSMC	(100 CIR., i=90°)		(ELLIPTICAL, i=63.5)
- TITAN 34D/NUS**	27500	--	12000(Wp=180)
- TITAN 34B*	6200	--	--
- 34D/CORE ONLY*	5600	--	--

* 10' x 25' PAYLOAD FAIRING ENVELOPE

**10' X 55' PAYLOAD FAIRING

ELV RELIABILITY

TITAN

- 107 SUCCESSFUL LAUNCHES IN 109 OPERATIONAL MISSIONS
- 98.2% RELIABILITY DEMONSTRATED

ELV MISSION RECORD FOR PAST 11 YEARS

<u>BOOSTER VEHICLE</u>	<u>NUMBER OF LAUNCHES</u>	<u>SUCCESS</u>	<u>FAILURE</u>	<u>PROJECTED RELIABILITY @ 90% C.L.</u>
TITAN	77	76	1	.951
DELTA	68	64	4	.8873
ATLAS	71	65	6	.8577

LAUNCH VEHICLE PERFORMANCE/COST COMPARISON

CONTRACTOR COSTS ONLY
81 \$ IN MILLIONS - RATE 4/YEAR

VEHICLE CONFIGURATION	ESMC GEO/TRANSFER			WSMC POLAR		
	PERF-LBS	COST	\$/LB	PERF-LBS	COST	\$/LB
DELTA 3920	2800	22.4M	8000	--	--	--
ATLAS						
SLV-3	--	--	--	4300	21M	4880
SLV-3/CENTAUR	4000	44M	11000	--	--	--
TITAN 34D						
34D TRANSTAGE	12000	65M	5417	--	--	--
34D IUS	12000	80M	6667	--	--	--
34D NUS	--	--	--	27500	49M	1782
34B	--	--	--	6200	32.7M	5274

PERFORMANCE GROWTH

GROWTH VERSION		PERFORMANCE (LBS)		LEAD TIME ATP TO IOC	ROM COST NON-REC FY-81 \$	REMARKS
		GSO	POLAR*			
SEVEN SEGMENT	T/S	5050	32000	33 MOS	\$74M :	MEETS REQUIREMENTS
	IUS	5350				THROUGH 1993
SEVEN SEGMENT	T/S	5350	34300	45 MOS	\$105M	PROVIDE SIGNIFICANT
PLUS STRETCH	IUS	5600				PAYLOAD GROWTH
STAGES I & II						CAPABILITY
34D/TRANSTAGE/ ORBITAL POSITION STAGE		4930**	--	20 MOS	\$30- \$40M	MEETS GSO REQUIREMENTS
34D/CENTAUR		8300	--	36 MOS	\$46M	PROVIDES PLANETARY CAPABILITY

* WSMC - 100 N.MI. POLAR ORBIT

**FMH 175 BTU/FT²HR

TITAN HAS ACCOMMODATION GROWTH

GROWTH VERSION	PERFORMANCE (LBS)		LEAD TIME ATP TO IOC	FY 81 \$ ROM COST NON-REC	REMARKS
	ESMC GSO	WSMC POLAR 100 NM			
16.7 FT DIA X 40' PAYLOAD FAIRING SEVEN SEGMENT	4600**	29900	33 MOS	26.3M	DIAMETER MEETS MISSION MODEL REQUIREMENTS
14.0 FT DIA X 68' PAYLOAD FAIRING SEVEN SEGMENT	4500	30250 26200***	30 MOS	18.8M*	TIIE DESIGN

- * 10.8M IF CONCURRENT WITH SEVEN SEGMENT SRM'S
- ** WITH TRANSTAGE
- *** REFERENCE MISSION 4 (WSMC)

TITAN 34D / 7 SEGMENT FEATURES

- EXISTING TECHNOLOGY
 - ENGINEERING 90% COMPLETE
 - TESTING 60% COMPLETE (FOUR STATIC TESTS)
 - BURN THRU ON 1ST FIRING
 - DESIGN CHANGE IMPLEMENTED AND VERIFIED ON NEXT 3
 - PROPELLANT SAME AS 34D WITH LOWER BURN RATE
 - MOTOR CASES/INSULATION - SAME
 - NOZZLE - SCALE UP FOR LARGER EXPANSION RATIO
 - THRUST VECTOR CONTROL - QUALIFIED FOR 7 SEGMENT
 - STRUCTURES BASIC 34D WITH MODIFIED AFT SKIRT SUPPORT AND GROUND/CORE SUPPORT FITTINGS
 - ORDNANCE, ELECTRICAL, INSTRUMENTATION - 34D
 - QUALIFICATION
 - REQUIRES - TWO STATIC TESTS
 - STRUCTURES TESTS WITH STEEL SIMULATORS
 - MINIMUM CORE CHANGES

5-1/2 SEGMENT SRM CONFIGURATION

BUILD COSTS

BOOSTER COSTS ONLY

FY 81 \$ IN MILLIONS

UNIT COST

RATE PER YEAR

	2	4	6	8	10
AIRFRAME	18.5	12.8	10.6	9.6	8.9
ENGINE	10.0	7.3	6.3	6.0	5.8
SRM	23.0	16.4	14.4	13.1	12.2
TOTAL	51.5	36.5	31.3	28.7	26.9

5-1/2 SEGMENT- SRM CONFIGURATION - COST SUMMARY

BOOSTER COSTS ONLY

FY 81 \$ IN MILLIONS

UNIT COST / RATE PER YEAR

	2	4	6	8	10
BUILD	51.5	36.5	31.3	28.7	26.9
LAUNCH	20.5	12.8	8.9	7.1	5.9
*CONTRACTOR TOTAL	72.0	49.3	40.2	35.8	32.8
**CUSTOMER	14.4	9.9	8.0	7.2	6.6
GRAND TOTAL	86.4	59.2	48.2	43.0	39.4

* EXCLUDES GFE, PLF OR UPPER STAGES

** 20% FOR SPARES, CHANGES, AEROSPACE, PROPELLANTS AND
TRANSPORTATION

7 SEGMENT SRM CONFIGURATION

BUILD COSTS

BOOSTER COSTS ONLY

FY 81 \$ IN MILLIONS

UNIT COST

RATE PER YEAR

	2	4	6	8	10
AIRFRAME	18.5	12.8	10.6	9.6	8.9
ENGINE	10.0	7.3	6.3	6.0	5.8
SRM	28.0	20.4	17.9	16.3	15.2
TOTAL	56.5	40.5	34.8	31.9	29.9

7 SEGMENT SRM CONFIGURATION - COST SUMMARY

BOOSTER COSTS ONLY

FY 81 \$ IN MILLIONS

UNIT COST / RATE PER YEAR

	2	4	6	8	10
BUILD	56.5	40.5	34.8	31.9	29.9
LAUNCH	20.5	12.8	8.9	7.1	5.9
* CONTRACTOR TOTAL	77.0	53.3	43.7	39.0	35.8
**CUSTOMER	15.4	10.7	8.7	7.8	7.2
GRAND TOTAL	92.4	64.0	52.4	46.8	43.0

* EXCLUDES GFE, PLF OR UPPER STAGES

** 20% FOR SPARES, CHANGES, AEROSPACE, PROPELLANTS AND
TRANSPORTATION

5-1/2 SEGMENT OR 7 SEGMENT SRM CONFIGURATIONS

LAUNCH COSTS

BOOSTER COSTS ONLY

FY 81 \$ IN MILLIONS

UNIT COST

RATE PER YEAR

	2	4	6	8	10
MMC	15.4	10.1	7.2	5.7	4.8
CSD	2.3	1.3	.8	.7	.6
ALRC	2.8	1.4	.9	.7	.5
TOTAL	20.5	12.8	8.9	7.1	5.9

MULTI-YEAR PROCUREMENT OF 9 OR 12 VEHICLES

CASE (A) 2 YEAR EQUIVALENT RATES OF 4.5 AND 6.0/YEAR

		<u>MMC</u>	<u>ALRC</u>	<u>CSD</u>	<u>TOTAL</u>	<u>1 YEAR PROCUREMENT</u>
9 VEHICLES 4.5/YR	BUILD	11.4	6.7	15.0	33.1	
	LAUNCH	9.4	1.3	1.1	11.8	
	TOTAL	20.8	8.0	16.1	44.9	47.1
12 VEHICLES 6.0/YR	BUILD	10.2	6.1	13.7	30.0	
	LAUNCH	7.2	.9	.8	8.9	
	TOTAL	17.4	7.0	14.5	38.9	40.2

MULTI-YEAR PROCUREMENT OF 9 OR 12 VEHICLES

CASE (B) 3 YEAR EQUIVALENT RATES OF 3.0 AND 4.0

		<u>MMC</u>	<u>ALRC</u>	<u>CSD</u>	<u>TOTAL</u>	<u>1 YEAR PROCUREMENT</u>
9 VEHICLES 3.0/YR	BUILD	13.8	7.7	18.3	39.8	
	LAUNCH	12.7	2.1	1.8	16.6	
	TOTAL	26.5	9.8	20.1	56.4	60.6
12 VEHICLES 4.0/YR	BUILD	11.7	6.8	15.6	34.1	
	LAUNCH	10.1	1.4	1.3	12.8	
	TOTAL	21.8	8.2	16.9	46.9	49.3

RECOMMENDATIONS

- ~~REVISE "SPACE TRANSPORTATION POLICY" TO PROVIDE A MIXED FLEET~~
- CONSOLIDATE ALL ELV'S TO SINGLE GENERIC SYSTEM
- SELECT TITAN 34D AS THE MIXED FLEET ELV
- USE TITAN 34D FOR PLANETARY AND INTELSAT MISSIONS
- INITIATE TITAN GROWTH OPTION FOR 1985 AND UP MISSION NEEDS

RECOMMENDED MISSION MODEL ~~CAPTURE~~ (ALTERNATE)

LOCATION	MISSION	34D	SHROUD	UPPERSTAGES
ESMC	DSCS iii	5 1/2 SEG	10'	IUS OR T/S
	DSP*	5 1/2 SEG	10'	IUS OR T/S
	PLANETARY HALLEY'S	5 1/2 SEG	10'	IUS OR T/S
	INTELSAT	5 1/2 SEG	14'	IUS OR T/S
WSMC	SM I	5 1/2 SEG	10'	NO UPPER STAGE
	DMSP	CORE ONLY	10'	NO UPPER STAGE

*ONE MISSION ONLY

ELV ~~CAPTURE~~ - FLIGHT COUNT* (ALTERNATE 5 1/2 SEG SRM'S)

LOCATION	84	85	86	87	88	89	90	91	92	93	TOTAL
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* BASED ON NASA FLIGHT PROJECTION IN POP 81-2 AND DOD MISSION MODEL 10
NEW BUY 37 VEHICLES (INCLUDING 7 CORE VEHICLES)